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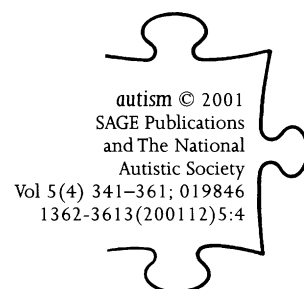
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# Predicting spoken language level in children with autism spectrum disorders



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**ABSTRACT** Thirty-five children who received an autism spectrum diagnosis at the age of 2 years (24 with autism, 11 with PDD-NOS) were re-evaluated 2 years later to examine factors related to the development of spoken language. Child variables (play level, motor imitation ability and joint attention) and environmental variables (socioeconomic status and hours of speech/language therapy between ages 2 and 3) were used to predict an aggregate measure of language outcome at age 4. After controlling for age 2 language skills, the only significant predictors were motor imitation and number of hours of speech/language therapy. Implications of these results for understanding the early developmental course of autism spectrum disorders and the effects of intervention are discussed.

**KEYWORDS**  
autism  
spectrum;  
motor  
imitation;  
speech and  
language  
therapy;  
spoken  
language

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Language is a culturally defined code (i.e. set of arbitrary symbols) whereby ideas about the world are conveyed for the purpose of communication. Spoken language is a verbal form of such a code. There is consensus that spoken language is the most efficient and widely understood modality of communication among hearing individuals. In children with autism, the acquisition of spoken language has been found to be a predictor of long-term outcome (Gillberg, 1991; Lotter, 1978). Given the prognostic and pragmatic importance of spoken language, it is surprising that few studies have attempted to identify early predictors of spoken language development in autism (Bristol et al., 1996; Prizant, 1996). Delineation of factors that are associated with the development of spoken language may have practical as well as conceptual implications. For example, it is possible that some variables that are predictive of later spoken language are alterable. Identifying alterable predictors of spoken language may enable us to develop

improved methods of intervention that will result in better outcomes for children with autism. Conversely, identifying predictors that are less alterable may eventually help us understand why some children with autism have a better prognosis than others.

The primary objective of this research is to examine the extent to which specific child variables and environmental variables present at the age of 2 years contribute to the prediction of language outcome in children with autism spectrum disorders 2 years later. The decision to obtain predictive information at age 2 was guided by theories of increased brain plasticity at young ages (Huttenlocher, 1994), as well as observations that early experiences and environmental influences play a significant role in shaping neural connections (Fischer and Rose, 1994). That is, the potential for influencing children's development through intervention may be greater at younger ages. Although we are not testing theories of brain plasticity directly, our aim is to study the characteristics of children, and their interventions, at the youngest ages possible.

An interactional approach to studying individual differences in developmental rate will be employed in the present study. Within this approach, a child's developmental outcome is viewed in terms of the interaction between the characteristics of the child and his/her family and social contexts (Sameroff and Chandler, 1975; Sameroff and Fiese, 1990). Provence and Dahl (1987) have applied a similar model to autism, suggesting that symptom severity is determined by the interaction between constitutional vulnerability and environmental factors. The importance of environmental contributions to language development has been documented by several investigators (e.g. Dale et al., 1987; Jordan, 1978). In the autism literature, environmental variables such as socioeconomic level (Robbins et al., 1991) and intervention intensity (Lotter, 1978; Lovaas, 1987) have been associated with outcome.

The environmental predictors used in the present study were: (1) socioeconomic level; and (2) amount of speech/language therapy received from a certified speech-language pathologist. These two predictors were selected to represent home as well as intervention influences. Socioeconomic level was considered to be important because occupational status and maternal education level have been found to contribute to individual differences in language and cognitive development in typically developing children (Alwin, 1984; Richman et al., 1992; Wright and Wright, 1976). Both aspects of socioeconomic status are thought to be related to parent-child interaction style, which is also associated with language development (Hoff-Ginsberg and Tardiff, 1995).

Amount of speech/language therapy was included as an environmental predictor for pragmatic reasons. There is now substantial evidence that the

provision of specialized educational and behavioral interventions at young ages can result in considerable gains in cognitive, language, social and behavioral functioning for children with autism (Bondy and Frost, 1995; Harris et al., 1991; Hoyson et al., 1984; Lovaas, 1987; Rogers and Lewis, 1989). However, there has not yet been an empirical demonstration that the amount of early speech/language therapy is associated with better language outcomes in this population.

Amount of speech/language therapy was operationalized as the number of hours of speech/language therapy received from a certified speech–language pathologist in the year between age 2 and age 3. The time period between ages 2 and 3 was selected for two reasons. First, it allows us to examine the effects of intervention received at the youngest age possible (i.e. immediately after diagnosis). Second, by restricting this measure to a 1 year period, and measuring language outcome 1 year later (i.e. at age 4), we can employ a longitudinal correlational design instead of a concurrent correlational design. Had we examined hours of speech/language therapy between the ages of 2 and 4, conclusions regarding the importance of early intervention – and the predictive nature of the relation between therapy and outcome – would have been more limited. Although we recognize that longitudinal correlations between therapy hours and outcome can neither provide information about directionality nor rule out alternative explanations for the relation between the variables, an association between time spent in speech/language therapy and later language would add to the support that speech/language therapy is beneficial for these children.

Theoretical and empirical work with typically developing children and/or children with disabilities has suggested three child variables as potential predictors of spoken language in children with autism: motor imitation, joint attention and object play. Motor imitation has been found to predict language level in typically developing children (Bates et al., 1979; Snow, 1989) as well as in children with autism (Stone et al., 1997). Motor imitation measures the child's ability to: (1) attend to another person; and (2) form a mental representation of the other person's behavior in sufficient detail to allow the child to replicate that behavior. In this way, motor imitation may be a measure of social information processing as well as representational ability. Both of these skills may underlie the child's ability to process linguistic input from parents and other adults and to acquire the language of his or her community.

Another developmental area of interest in the present study is the child's ability to communicate for the purpose of directing an adult's attention to an object or event of interest (i.e. joint attention). Previous research has found that a number of joint attention acts predict later spoken vocabulary or expressive language development in children with general developmental

delays (McCathren et al., in press; Mundy et al., 1995) and in children with autism (Mundy et al., 1990; Sigman and Ruskin, 1999). Joint attention acts are thought to be related to language acquisition for three reasons. First, these acts may signal the child's desire for maternal linguistic input (Locke et al., 1990). Language input may be particularly likely to facilitate language development in children with autism when given at times the children are seeking such information (Koegel et al., 1998). Second, joint attention acts may serve to elicit linguistic input from adults (Franco et al., 1996; Kessler-Shaw, 1992). Linguistic responses to children's pre-linguistic communication have been found to predict later language in children with developmental disorders (Yoder and Warren, 1999). Third, children who engage in high levels of joint attention may be those with a particular interest in sharing their experience with adults (Mundy, 1995). Bloom (1993) hypothesized that the primary reason children learn to talk is to share the contents of their minds.

A third developmental area with links to language is children's object play. The development of object play in children with autism has been found to follow the same general sequence as that seen in typically developing children (Lifter et al., 1993). Level of object play has been related longitudinally to spoken language in typically developing children (Bates et al., 1979; Tamis-LeMonda and Bornstein, 1994) and children with developmental disabilities (McCathren et al., 1998). In children with autism, concurrent as well as predictive relations between object play and language level have also been described (Mundy et al., 1987; Sigman and Ruskin, 1999; Sigman and Ungerer, 1984). In addition, certain measures of symbolic play (i.e. amount or highest level) have been related concurrently to language in typically developing children (Bloom, 1993; McCune, 1995) and in children with developmental disabilities (Casby and Ruder, 1983; Mundy et al., 1988). Piaget (1962) hypothesized that representational skills (i.e. the ability to use one thing to represent another) underlie the development of both symbolic play and language.

In summary, the primary purpose of this study was to identify early child and environmental predictors of spoken language development in children with autism. A secondary purpose was to determine whether the amount of time young children with autism spend in speech/language therapy is related to their later language level. This study represents a unique contribution to the autism literature in several ways. First, our predictor variables were measured at very young ages. Although there have been empirical demonstrations that autism can be diagnosed reliably in 2-year-old children (Cox et al., 1999; Lord, 1995; Stone et al., 1999), few prospective studies have been conducted with children so young. Second, the present study was designed to predict language level over a longer interval

than have most previous studies. Whereas most studies of children with autism have predicted over a 12 month interval (e.g. Mundy et al., 1990; Stone et al., 1997), the present study predicts language level over a 2-year period. Third, the current study controls for age 2 language level in the key predictive analyses. This procedure ensures that any relations that are found between predictors and later language are not the result of individual differences in children's initial language level (Barnes et al., 1983; Yoder and Kaiser, 1989). Finally, this research adds to our knowledge about early intervention effects by evaluating the contribution of early speech/language therapy to later language outcomes.

## Method

### Participants

Participants were 35 children (27 boys, 8 girls) who received a diagnosis of either autism ( $n = 24$ ) or PDD-NOS ( $n = 11$ ) before their third birthday. All children were recruited from a regional diagnostic evaluation center between October 1993 and August 1995. None of the children had received a formal diagnosis of autism spectrum disorder prior to their evaluation at the center. Children's diagnoses were made by licensed psychologists who were participating in a multidisciplinary assessment team. Diagnostic formulations were based on criteria provided by either DSM-III-R or DSM-IV (American Psychiatric Association, 1987; 1994). The Childhood Autism Rating Scale (CARS) (Schopler et al., 1988) was also completed for all children by the team psychologist. Twenty-three of the 24 children in the autistic subgroup obtained CARS scores within the range of autism; one child missed the cutoff by one point. Among the PDD-NOS subgroup, 55 percent (6/11) obtained CARS scores within the range of autism. The sample was 77 percent Caucasian and 17 percent African American, with 97 percent of mothers having received a high school education or beyond.

Children received two yearly follow-up evaluations through their participation in a federally funded longitudinal research project. The age 4 follow-up evaluations, which are of interest for this particular study, occurred an average of 27 months (range = 23–31;  $SD = 2.1$ ) after the initial evaluations. Sample characteristics at both time points are presented in Table 1.

### Procedures

Clinicians serving as children's case managers identified eligible participants (i.e. children under 3 years receiving a diagnosis of autism or PDD-NOS) on the day of their diagnostic evaluation and provided a brief

**Table 1** Sample characteristics

	Age 2	Follow-up
Chronological age (months):		
Mean (SD)	30.9 (3.5)	57.9 (4.5)
Range	23–35	50–67
Mental age (months): <sup>a</sup>		
Mean (SD)	17.2 (3.8)	47.4 (16.2)
Range	11–26	15–70
Expressive language age (months):		
Mean (SD)	12.5 (5.1)	25.5 (11.0)
Range	3–28	8–56
Expressive vocabulary (no. words):		
Mean (SD)	32.6 (60.1)	276.7 (228.9)
Range	0–265	0–695

<sup>a</sup> At age 2, mental age was derived from the Bayley-II. At follow-up, mental age was derived from the Leiter International Performance Scale ( $n = 22$ ), the Merrill-Palmer Scale of Mental Tests ( $n = 6$ ), or other cognitive/developmental measures ( $n = 7$ ), based on clinical appropriateness.

description of the study to the parents. Interested parents were given informed consent forms to read, and signatures were obtained prior to initiation of research procedures. Participation in the follow-up study involved monthly telephone calls to parents and annual clinic re-evaluations for children for 2 years. Only data from the initial age 2 evaluation and the age 4 follow-up evaluation will be reported in the present study; these evaluation periods will be referred to as age 2 and follow-up.

At the age 2 evaluation, children were seen in an outpatient clinic by a psychologist, a speech-language pathologist and a developmental pediatrician. They received standardized measures of cognitive/developmental functioning and speech-language skills, along with research measures that included assessment of play and imitation skills. Parents participated in a structured interview and completed a questionnaire assessing their child's language functioning. Because these children had not received a formal diagnosis prior to their age 2 evaluation, parents were blind to their child's diagnosis when providing behavioral information. Moreover, the children were not yet receiving intervention services specialized to autism at this time.

At the age 4 follow-up evaluation, similar procedures were employed, with the exception that the medical evaluation and play assessment were not conducted. The specific measures used in the present study are described below.

## Child measures

**Motor Imitation Scale (MIS) (Stone et al., 1997)** The MIS is an observational measure that consists of 16 single-step imitation activities. Half of the items require the imitation of actions with objects (e.g. hopping a toy dog across the table) and the other half require the imitation of body movements (e.g. patting one's cheek). The examiner models an action and then encourages the child to repeat the action by saying, 'Do this.' Three opportunities are given, and only immediate imitative responses are scored. Responses to each item are scored as pass, emerge, or fail, according to specific criteria. A pass earns 2 points, an emerge earns 1 point, and a fail earns no points. Scores for each item are summed to yield a total score that can range from 0 to 32. The total score was used as the measure of motor imitation ability at age 2. Previous research on the MIS has revealed adequate internal consistency (standardized alpha = 0.88) and 2 week test-retest reliability ( $r = 0.80$ ) for the total score (Stone et al., 1997).

**Play Assessment Scale (PAS) (Fewell, 1991)** The PAS is an observational measure of play development that spans the 2 month to 36 month age levels. This measure is administered by presenting different sets of play materials and recording the child's spontaneous use of objects. Play behaviors on the PAS are sequenced developmentally, and a raw score is calculated on the basis of the child's basal and ceiling performances. The PAS items within the developmental range attained by children in this study consisted primarily of those assessing the manipulation of toys in a sensory, functional or symbolic manner; this measure thus focused more on cognitive than interactive aspects of play behavior.

Because there was no need to compare scores with a normative sample to address our research questions, the present study used raw scores as the measure of play level at age 2. Interobserver agreement for raw scores was calculated on a subsample of 12 children (34 percent) using intraclass correlations; the resulting generalizability coefficient was 0.94.

**Parent Interview for Autism (PIA) (Stone and Hogan, 1993)** The PIA is a structured parental interview designed to elicit diagnostically relevant information from parents of children with suspected autism spectrum disorders. Items on this instrument describe behaviors that are rated on a scale from 1 to 5, corresponding to the frequency of occurrence (with higher numbers reflecting greater frequency). Five items from the PIA were used to measure *joint attention*: directing the parent's attention by pointing to or showing objects; sharing enjoyment with the parent during preferred activities; communicating for the purpose of getting the parent's attention;



showing off; and communicating to direct attention to something the child is interested in. All of these items measure the initiation of joint attention, rather than the response to joint attention, because the former is thought to be more likely to elicit linguistic input from others. Internal consistency for these five items yielded a standardized alpha of 0.83. Responses to the five items were summed to obtain a joint attention score ranging from 5 to 25; this score was used as the age 2 measure of joint attention. PIA joint attention items have been used successfully in previous research on language development by an independent research group. Crowson and Stella (1999) found that a composite score comprising three of the PIA joint attention items (i.e. getting attention, showing off and conveying interest) predicted expressive language 1 year later in a sample of children with autism.

**Expressive language measures** Expressive language was measured via direct observation and parental report. The parental report measure of expressive language used was the MacArthur Communicative Development Inventory (MCDI) (Fenson et al., 1993). This measure was administered at age 2 and follow-up. The direct observation measures used were the Sequenced Inventory of Communication Development–Revised (SICD–R) (Hedrick et al., 1984) and the Preschool Language Scale (PLS–3) (Zimmerman et al., 1991). Both measures were administered by a certified speech–language pathologist. As described below, the SICD–R was administered at the age 2 evaluation and the PLS–3 was used during the follow-up evaluation.

The MCDI (Fenson et al., 1993) is a parental report instrument of early child language that includes a vocabulary checklist. Parents use this checklist to indicate the specific words their child understands (comprehension) and the specific words their child says (production). Vocabulary production (i.e. total number of words said) was used as a measure of expressive vocabulary in the present study. In an attempt to guide parents in reporting only those words used in a communicative and contextually appropriate manner, the MCDI instructions for vocabulary production require parents to indicate those words that the child ‘says and understands’. Adequate levels of internal consistency for the MCDI have been reported (i.e. 0.95–0.96), and correlations between MCDI vocabulary production and other expressive language measures range from 0.61 to 0.85 (Fenson et al., 1993). The Words and Gestures version of the MCDI was used in this study.

The SICD–R (Hedrick et al., 1984) was given to all children at the age 2 evaluation. This instrument was developed to evaluate the receptive and expressive language skills of children from 4 months to 4 years of age. Psychometric properties are adequate in terms of interexaminer reliability (90–100 percent), test–retest reliability (0.88–0.99) and correlations with

other language measures (0.74–0.95) (Hedrick et al., 1984). The SICD–R was part of the standard assessment protocol used in the diagnostic clinic for 2-year-olds. It was chosen because its emphasis on manipulatives rather than pictorial stimuli renders it more appropriate for children functioning at very early levels of language development. Expressive language age equivalent scores were used in the present study.

The PLS–3 (Zimmerman et al., 1991) was given at the follow-up evaluation. This instrument is a direct measure of language comprehension and use that was designed for children ranging in age from 2 weeks to 7 years. Interrater reliability (89 percent), internal consistency (0.85–0.91 for 2- to 4-year-olds) and concurrent validity ( $r = 0.75$  with the CELF–R) are all adequate (Zimmerman et al., 1991). The PLS–3 was selected for use at outcome because of its higher upper age limit. The expressive communication age equivalent score was used in the present study. Seven children (20 percent) were unable to respond to the picture-based stimuli on the PLS–3; for these children, the SICD–R was given and the SICD–R expressive language age equivalent score was used in data analyses. Subsequent analyses revealed that this subgroup did not differ from the rest of the sample in terms of any age 2 or follow-up variables.

**Expressive language aggregate** To increase the validity of our estimate of expressive language, data from the two different types of language measures (i.e. the number of words used according to parental report and the expressive language age equivalency obtained from standardized testing) were combined to create an expressive language aggregate for spoken language. According to classical measurement theory, the validity of a construct can be increased by combining valid, but non-redundant, measures of that construct (Allen and Yen, 1979; Baggaley, 1988). In this case, aggregates were formed because: (1) parental report and direct observation have each been found to represent valid measures of different aspects of language (Bornstein et al., 1998); and (2) we wanted our expressive language measure to reflect children's use of language across different types of settings (i.e. home and clinic, structured and unstructured). Many previous studies have combined individual measures to create more valid measures of language, using methods such as factor analysis and structural equation modeling (e.g. Bornstein et al., 1998; Whitehurst et al., 1994). The method employed in the present study was selected because of its greater appropriateness for our sample size.

Separate aggregates were created for the age 2 evaluation and the follow-up evaluation. Because our component language measures have different scales, scores from each measure were converted to  $z$ -scores, and then the  $z$ -scores were averaged to create the aggregate. Each of the

component language measures used in this study (i.e. the MCDI and the two standardized language tests) requires that language be used referentially in a social context to be credited. The language aggregates thus can be considered to measure contextually appropriate language as demonstrated across different settings.

## **Environmental measures**

**Hollingshead Four Factor Index (Hollingshead, 1975)** This instrument was used to assess the family's socioeconomic status (SES). The reliability and validity of the Hollingshead are well established (Gottfried, 1985; Hollingshead, 1975). On this measure, points are assigned for parental occupation and level of education, and are summed to derive an SES score that can range from 8 to 66. This SES score was used in the present study.

**Intervention interview** This structured interview was developed for use in the longitudinal study to measure the number of hours of different types of intervention received. The interview was conducted by research assistants during monthly telephone calls to parents. For each form of intervention received (e.g. occupational therapy, educational intervention, speech/language therapy), information was obtained about the start and end dates, the duration of each session, and the number of sessions attended and missed during the previous month. Our original intent in designing this measure was to also gather information about the nature of the intervention provided. However, it soon became apparent that parents were unable to provide information about the qualitative aspects of the intervention, in part because a substantial portion occurred at school. Moreover, characterizing the nature of therapy was complicated by the frequent occurrence of changes in services and service providers over the course of the year.

As a result, the intervention measure used in the present study was the number of hours of speech/language therapy received in the 52 weeks following initial diagnosis (i.e. between the ages of 2 and 3). The majority of children (61 percent) obtained speech/language therapy from both community-based providers and school-based providers over the course of the year; the prototype was to receive community services before the age of 3, and then switch to school services after starting public school programs at age 3. Twenty-three percent of the children received community-based services only, and 16 percent received school-based services only. Most children (55 percent) received a combination of individual and group speech/language therapy over the course of the year, with 42 percent receiving individual therapy only, and 3 percent receiving therapy in a group format only.

**Table 2** Descriptive data for measures

Measure	Mean (SD)	Range
Imitation (MIS)	12.3 (8.0)	1–31
Joint attention (PIA)	14.0 (5.3)	6–23
Play (PAS)	18.0 (5.1)	8–28
SES (Hollingshead)	39.8 (14.0)	11–66
Total hours of speech/language therapy <sup>a</sup>	70.3 (68.7)	0–303.5
Total hours of educational intervention <sup>b</sup>	360.6 (344.5)	0–1225.0
Total hours of other therapies <sup>c</sup>	19.7 (32.5)	0–141.5

<sup>a</sup> Refers to the number of hours spent in speech/language therapy, provided by a certified speech–language pathologist, in the 52 weeks following the initial evaluation.

<sup>b</sup> Refers to the number of hours spent in developmental preschool or public school special education classrooms in the 52 weeks following the initial evaluation.

<sup>c</sup> Refers to the number of hours spent in other therapies, such as occupational therapy and behavioral therapy, in the 52 weeks following the initial evaluation.

## Results

The means, standard deviations and ranges for the child and environmental predictor variables are presented in Table 2.

Two sets of preliminary correlational analyses were conducted. The first analysis was conducted to determine the relation between the expressive language variables comprising the aggregates. Results revealed that the component language variables comprising the expressive language aggregate were highly intercorrelated at both time periods. The Pearson correlation coefficient for the relation between expressive language age equivalent and number of words said was 0.55 ( $p < 0.001$ ) at age 2 and 0.83 ( $p < 0.001$ ) at follow-up.

The second preliminary analysis was conducted to examine the intercorrelations between the age 2 variables and follow-up expressive language. These correlations are presented in Table 3. As anticipated, age 2 expressive language was highly correlated with follow-up expressive language ( $r = 0.72$ ,  $p < 0.001$ ). Among the three age 2 child variables, play and imitation correlated significantly ( $r = 0.61$ ,  $p < 0.001$ ), though joint attention correlated with neither ( $r = -0.06$  for play and 0.10 for imitation,  $ps > 0.50$ ). The two environmental variables, SES and speech/language therapy, were correlated significantly ( $r = 0.35$ ,  $p < 0.05$ ). Of the five age 2 child and environmental variables, four were correlated significantly with follow-up expressive language: joint attention ( $r = 0.34$ ,  $p < 0.05$ ); motor imitation ( $r = 0.55$ ,  $p < 0.01$ ); object play ( $r = 0.36$ ,  $p < 0.05$ ); and hours of speech/language therapy ( $r = 0.48$ ,  $p < 0.01$ ).

**Table 3** Intercorrelations between variables

	<i>Jt Attn</i>	<i>Play</i>	<i>SES</i>	<i>Sp./lang. therapy</i>	<i>Age 2 language</i>	<i>Follow-up language</i>
<i>Imitation</i>	0.10	0.61***	-0.10	0.00	0.44**	0.55**
<i>Jt Attn</i>	–	-0.06	0.16	0.40*	0.30	0.34*
<i>Play</i>	–	–	0.13	0.06	0.25	0.36*
<i>SES</i>	–	–	–	0.35*	0.26	0.20
<i>Sp./lang. therapy</i>	–	–	–	–	0.20	0.48**
<i>Age 2 language</i>	–	–	–	–	–	0.72***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Because expressive language skills at age 2 and follow-up were expected (and confirmed) to be highly correlated, the objective of this study was to determine which age 2 variables predicted later expressive language over and above the effects of initial language level. Potential predictors of follow-up expressive language were thus identified by computing partial correlations between the age 2 child and environmental variables and the follow-up language outcome variable, controlling for age 2 language. Those variables with non-significant partial correlations were not considered in further analyses. Those predictors with significant partial correlations were used in multiple regression analyses to identify which predictors accounted for unique variance after controlling for the other predictors.

Partial correlations revealed that two variables continued to be significant predictors of later expressive language after controlling for age 2 expressive language. These variables were motor imitation (partial  $r = 0.38$ ,  $p < 0.05$ ) and hours of speech/language therapy (partial  $r = 0.50$ ,  $p < 0.005$ ). This analysis thus resulted in the exclusion of three variables from further consideration; the excluded variables were SES (partial  $r = 0.02$ ,  $p = 0.93$ ), object play (partial  $r = 0.27$ ,  $p = 0.12$ ) and joint attention (partial  $r = 0.18$ ,  $p = 0.31$ ).

In the multiple regression, age 2 expressive language was entered in the first block, motor imitation was entered in the second block, and hours of speech/language therapy were entered in the third block. The results are presented in Table 4. Both motor imitation and hours of speech/language therapy were unique predictors of later language after controlling for initial language level.

In light of these results, *post hoc* analyses were conducted to further examine the role of speech/language therapy in predicting later expressive language outcome. In the first analysis, the relation of speech/language

**Table 4** Results of multiple regression for predicting expressive language at follow-up

Age 2 variable	R <sup>2</sup>	R <sup>2</sup> change	F change	p
Expressive language	0.52	0.52	36.4	0.0001
Motor imitation	0.59	0.07	5.2	0.029
Hours in speech/language therapy	0.73	0.14	15.6	0.0001

therapy to other therapies the children received within the same time period was examined. It was important to determine whether the effect of speech/language therapy was unique to this form of intervention, or whether it may have reflected a more generalized effect of participating in any form of intervention. Two categories of interventions other than speech/language therapy were used for this analysis: educational intervention and other therapies. Educational intervention was defined as participation in a developmental preschool or a public school special education classroom. Other forms of interactive (i.e. non-drug) treatments, such as occupational therapy and behavioral interventions, were combined to form a category of other therapies (see Table 2 for means, standard deviations and ranges for these measures.)

Correlations between number of hours in speech/language therapy, number of hours in educational intervention, and number of hours in other interventions were calculated. Results revealed that speech/language therapy hours were not correlated significantly with hours spent in either of the other intervention categories,  $r = 0.09$  for educational intervention and  $0.09$  for other therapies,  $ps > 0.60$ .

It was also important to determine whether participation in other forms of therapy was also associated with later language outcome. Correlational analysis revealed that neither hours of participation in educational intervention ( $r = -0.25$ ) nor hours spent in other therapies ( $r = 0.25$ ) correlated significantly with follow-up expressive language,  $ps > 0.10$ .

## Discussion

The primary aim of this study was to determine the child and environmental predictors of expressive language development in young children with autism spectrum disorders. Our results revealed that stronger motor imitation skills at age 2 and more hours of participation in speech/language therapy between ages 2 and 3 were associated with better expressive language outcomes 2 years later. The potential importance of this finding is

highlighted by the fact that these two variables predicted language outcome over and above the effects of initial language level. That is, imitation and speech/language therapy made independent contributions to the prediction of spoken language skills even after controlling for age 2 language skills. Moreover, the use of an aggregate measure of expressive language at age 4 reduces the likelihood that these results are an artifact of the methods used to measure language skills. Because the aggregate measure of language outcome was based on data obtained through parental report as well as direct observation, it is unlikely that the results were biased by method variance (i.e. obtaining higher correlations between variables obtained via the same source).

These findings have several implications for our understanding of the nature and course of autism. The finding that motor imitation predicted language level is consistent with previous research employing typically developing children (Bates et al., 1979; Snow, 1989), and suggests that similar social-cognitive prerequisites may underlie the early development of language in children with autism and those with typical development. Motor imitation, like spoken language, is a multifaceted behavior with social as well as representational components. Successful performance on immediate motor imitation tasks – such as those on the MIS – requires attention to and understanding of the social demands of the situation, as well as motivation to share an activity with another person (Rogers and Pennington, 1991; Yando et al., 1978). The abilities to form social representations (Rogers and Pennington, 1991) as well as representations of movements (Smith and Bryson, 1994) have been linked theoretically to successful motor imitation. The high correlation (0.61) obtained between imitation and object play in the present study further supports the representational aspect of motor imitation. Because of its social and representational components, as well as the relative ease with which it can be assessed, motor imitation ability may be a particularly useful early indicator of future language development in children with autism spectrum disorders.

In contrast, it was curious that the other child variables – joint attention and object play – were not significant predictors of expressive language development, as previous research (i.e. Mundy et al., 1990; Sigman and Ruskin, 1999) would suggest. Although both variables were correlated with follow-up language, the correlations became non-significant when age 2 language was controlled. Of the studies focusing on children with autism, only Sigman and Ruskin (1999) controlled for the effects of initial language level. Although these authors found a relation between joint attention and expressive language skills, it was only children's response to joint attention bids that predicted language beyond 1 year. In contrast, our joint attention measure consisted entirely of items measuring the initiation of joint

attention. It may therefore be the case that the ability to respond to joint attention bids of others is a more sensitive measure than the initiation of joint attention at young ages.

The relation between joint attention and expressive language also may have been attenuated in the present study owing to the age of our participants. In contrast to the Sigman and Ruskin (1999) study, our children were all under age 3 at the time of enrollment, and thus represented a younger sample. It is possible that prediction over time is more difficult for such young children, because increased brain plasticity may lead to a wider range of outcomes. This phenomenon may also explain our failure to obtain a significant relation between object play and later language (after controlling for age 2 language).

Another important difference between the Sigman and Ruskin (1999) study and the present study is the manner in which joint attention was measured. Sigman and Ruskin employed an observational measure of joint attention, the Early Social-Communication Scales (ESCS) (Seibert et al., 1982), whereas the present study used a parental report measure. It is possible that parents are less likely to recognize the subtle aspects of joint attention behaviors in their children. Additionally, parents and clinicians may have different interpretations and attributions of children's social-communicative behaviors. This interpretation is supported by Crowson and Stella's (1999) findings that observational and parental report measures of joint attention were not correlated. Thus it may be the case that parental report of joint attention is a less sensitive measure than direct observation. However, it is important to note that Crowson and Stella found that both observational and parental report measures predicted language development 1 year later in a sample of young children with autism. Moreover, their parental report measure comprised a subset of the same PIA items as those employed in the present study (Crowson and Stella, 1999). Further study of the nature of joint attention and its relation to other developmental skills, both concurrently and longitudinally, may aid our ability to understand and interpret these results.

Our secondary aim was to determine whether participation in speech/language therapy at the age of 2 would be associated with later language outcome. Our results revealed a strong positive association between number of hours of speech/language therapy and children's expressive language skills at age 4. This association was apparent even after the effects of age 2 language and imitation skills were controlled. Moreover, the association between early intervention and expressive language appears to be specific to speech/language therapy. Although most children spent considerably more time in educational interventions (i.e. developmental preschool or public school special education classrooms) than in



speech/language intervention, only the latter therapy was associated with expressive language outcome.

This finding suggests the importance of providing speech/language therapy to young children with autism spectrum disorders. Unfortunately, many unanswered questions about the nature of the relation between speech/language therapy and language outcome remain. For example, our findings do not necessarily indicate that speech/language therapy caused the individual differences in language outcome. Second, we do not know which aspects of speech/language therapy may be most beneficial. In contrast to educational interventions, speech/language therapy may be more likely to occur within the context of individual sessions, and to encourage parental involvement. Variables such as the proportion of time spent in individual v. group therapy, and the extent to which parents are involved in therapy, should be examined in future research. In addition, this study did not examine the specific approaches employed in the speech/language therapy sessions, such as the proportion of time spent on different goals such as receptive vocabulary or pragmatics. Further study of the optimal number of hours per week and the relative efficacy of different approaches is clearly needed.

One potential mediator of the strong relation between speech/language therapy and language outcome is parental expectancies. It is possible that parents who bring their child to therapy more often have an expectation for greater language gains that are then reflected on the follow-up parental report vocabulary measure. While this possibility cannot be ruled out entirely, its likelihood is reduced by our use of an aggregate measure of spoken language at outcome. Although parental expectations may color their own reports, it is unlikely that they would affect the results of standardized language testing.

Another possible mediator of the effect of speech/language therapy might be increased testability of the children. Through participation in speech/language therapy, children may be learning important work behaviors, such as sitting at a table and responding to adult requests. These behaviors may, in turn, lead to higher levels of cooperation – and superior performance – during language testing at follow-up. Again, this interpretation is inadequate for explaining outcome as operationalized by our aggregate language measure. While improved test-taking behaviors may affect performance in a standardized testing situation, they are not as likely to influence parental reports of vocabulary development.

Our other environmental variable, SES, was not related to language outcome. SES may have failed to predict follow-up outcome because it is a distal measure of the individual differences in the amount and type of interactions the children experience (Hoff-Ginsburg and Tardiff, 1995).

Although SES has been shown to covary with parental responsiveness to children's communication (Hoff-Ginsburg and Tardiff, 1995), not all parents at low SES levels are less responsive to their children. Thus, more proximal measures of maternal-child interactions and language stimulation may be more successful predictors of later language.

The language outcome measure employed in the present study was an aggregate designed to assess the use of referential and contextually appropriate language as demonstrated across different settings. Although there were clear advantages of using an aggregate language outcome measure, one limitation of this procedure is that we were unable to examine more specific language outcomes, such as how many meaningful words children were using on a daily basis, and how many children were speaking fluently. These types of functional language measures are clearly important for understanding the variability of language outcomes in children with autism. Further examination of specific outcomes such as these – and their early correlates – would be an important direction for future research.

Another limitation of this study is the use of different observational measures of language functioning at the age 2 and follow-up evaluations. The measures we used were selected on the basis of clinical as well as research considerations. While it may have been ideal to use the PLS-3 at both time periods, the SICD-R was included in the initial clinical battery of language assessments because of its greater appropriateness for the severe language delays commonly seen in young children with autism spectrum disorders. By the same token, because of its higher upper age limit, the PLS-3 was judged to be better suited for most 4- to 5-year-old children. It is possible that the use of different measures attenuated the relation between the age 2 and follow-up language aggregates. In that case, covarying for age 2 language might have resulted in an undercorrection, leading to higher partial correlations than those that might have been obtained if the same tests were used at both time periods.

In sum, the results of the present study suggest that both child and environmental factors contribute to language outcome in children with autism. Children's motor imitation skills at age 2, as well as the number of hours of speech/language therapy they received between age 2 and 3, were both significant predictors of spoken language ability at age 4. These results not only add to the growing literature on the importance of early intervention for children with autism, but also highlight the potential utility of motor imitation as an early predictor of language ability in children with autism.

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